The items are put into rank order where the highest value ranks as 1. d is the difference between each pair of rank variables.

The formula for Spearman Rank ρ (rho) is shown in Equation 5.1:

Equation 5.1

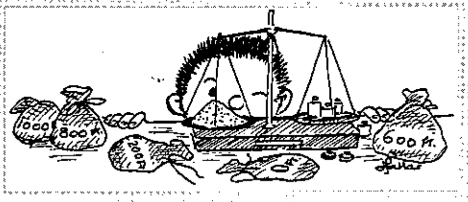
$$\rho = 1 - \left(\frac{6\Sigma d^2}{n^3 - n}\right)$$

where n is the number of observed pairs (in this case 10). There are n (= 10) degrees of freedom.

Equation 5.2

$$\rho = 1 - \left(\frac{6 \times 274}{1000 - 10}\right)$$

$$= 1 - \left(\frac{1644}{990}\right) = -\mathbf{0.66}$$



Referring to the appropriate significance tables (Appendix 5) we see that −0.66 lies between the confidence levels 95% and 99%, and so we can reject our null hypothesis.

Hence we have shown that there is a significant negative correlation between altitude and seed production in the soft rush. It must be stressed that this is not necessarily the direct effect of one variable on the other. With altitude, temperatures decrease and wind-speeds generally increase and these may well be the direct influences on the seed production of the soft rush. **Detection of a significant correlation does not imply a causal relationship.**

Example 2

The relationship between car ownership and population density in a British city.

Null Hypothesis (H_0)
There is no relationship between the proportion of cars per head of population and the population density.

The data are given in Table 5.3 below:

Table 5.3

Car ownership (cars/1000)	Rank	Population per unit area	Rank	d	d^2
126	7	10.1	8	−1	1
151	2	8.4	10	−8	64
101	11	22.0	2	9	81
106	10	17.3	3	7	49
132	4	9.1	9	−5	25
79	12	27.3	1	11	121
145	3	16.5	4	−1	1
107	9	15.0	5	4	16
127 *	5.5	3.5	12	−6.5	42.25
182	1	11.3	7	−6	36
118	8	11.5	6	2	4
127 *	5.5	4.4	11	−5.5	30.25
				$\Sigma d^2 = 470.5$	

* When two values are identical then the average rank value is given to each.

Equation 5.3

$$\rho = 1 - \left(\frac{6\Sigma d^2}{n^3 - n}\right)$$

$$\rho = 1 - \left(\frac{6 \times 470.5}{1728 - 12}\right)$$

$$= 1 - \left(\frac{2823}{1716}\right) = -\mathbf{0.65}$$

For 12 degrees of freedom this result is significant between 95% and 99%. The null hypothesis can therefore be rejected. Hence we can state that there is a significant negative relationship between car ownership and population density.